SOUTHEAST REGIONAL CLIMATE CENTER

Southern AER

ATMOSPHERIC EDUCATION RESOURCE

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In This Issue:

Did You Know?

The U.S. averages about 1,200 tornadoes each year, but only about 20 of those are 'killer' tornadoes, claiming a total of about 60 lives and injuring about 20 times as many people each year.

Tornado Ingredients: A Recipe for Disaster

Tornadoes are among the most awesome and most destructive forces of nature. A strong tornado can easily destroy most everything in its path, severely injuring or killing anyone who does not seek proper shelter.

Although scientists are still conducting research into exactly why some thunderstorms produce tornadoes while others don't, there are a few basic ingredients that help create this recipe for disaster.

First, the formation of the type of severe thunderstorms that usually produce tornadoes requires the presence of two very different air masses. This usually occurs when warm, moist air close to the ground move inland from the Gulf of Mexico and collides with cooler, drier air from the northwest higher up in the atmosphere. Instability, which is the tendency for rising air to continue to rise, helps develop the towering thunderstorm clouds that can produce tornadoes. The strongest type of thunderstorms (and the kind that most often produce tornadoes) are called **supercells**.

The key ingredient in tornado development is **wind shear**, which means that winds aloft are much stronger than they are near the ground. Wind shear creates a rolling motion along the ground, much like if you blew on a paper towel tube to make it roll across the floor. Strong updrafts within the thunderstorm tilt this rolling column of air upward so that it begins to rotate vertically, creating a rotating section of the thunderstorm that's known as a **mesocyclone**. As the mesocyclone develops, part of it may drop down from the base of the thunderstorm, creating a **wall cloud**. It is from the wall cloud that the smaller, tightly-spinning **funnel cloud** will descend. When the funnel cloud touches the ground, it becomes a tornado.

Many different weather "ingredients" go into the making of a tornado.

Image courtesy of NOAA Photo Library

If forecasters suspect that the ingredients necessary for tornado development are present, they will issue a tornado **watch**. If a tornado is actually forming or has already touched down, they will issue a tornado **warning**.

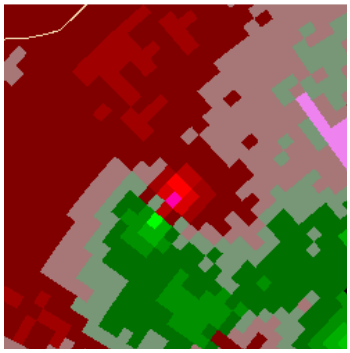
After National Weather Service (1992)

Doppler Radar: Looking Inside the Storm

One of the greatest advancements in being able to warn the public of a developing tornado has come in the form of **Doppler radar** (also known as **NEXRAD**, or **NEX**t generation weather **RAD**ar). Conventional radar sends out radio waves that bounce off objects they encounter, such as raindrops or hail. The radio waves are sent back to the radar and tell it the location and intensity of precipitation.

Doppler radar goes one step further. It can not only detect the location and intensity of a storm, but also whether it's moving toward or away from the radar antenna. It does this by using the Doppler effect, first discovered by Austrian scientist Christian Doppler in 1842. The Doppler effect measures the difference in frequency of the radio waves as they are returned to the radar antenna. Waves bouncing back from an object moving toward the antenna have a higher frequency, while those returning form an object moving away from the antenna have a lower frequency. This is the same principle that explains why the sound of an emergency vehicle's siren has a higher pitch as it's moving toward you and a lower pitch as it moves away from you.

The Doppler radar converts the returning radio waves into different colored pixels on the radar display, depending on whether they're showing motion toward or away from the antenna. Different colored pixels that are close to each other on the display indicate rotation in the thunderstorm and the possibility that a tornado may be forming. This is known as a **Tornado Vortex Signature**, or TVS and allows forecasters to warn the public of impending danger often before a tornado has touched the ground.



A portion of a Doppler radar display showing a tornado vortex signature (TVS). The red area shows winds blowing toward the radar; the green areas away from it. This indicates rotation in the thunderstorm and the possibility of tornado development

The F-Scale: Measuring the Damage

After a tornado hits an area, a team of experts is sent out by the National Weather Service (NWS) to assess the damage. Based on their findings, they classify the tornado based on the highest level of damage caused according to the Fujita Scale, or F-Scale. The F-Scale was first developed by Dr. T. Theodore Fujita at the University of Chicago in 1971 and was put into use by the NWS in 1973. The scale, shown on the left, classifies tornadoes based on the amount of damage they cause—the wind speeds given are only estimates and have never actually been verified scientifically. Nevertheless, the F-Scale provides an important tool in assessing the severity of one of nature's most destructive storms.

The Fujita Scale (F-Scale) of Tornado Intensity

Category	Wind Speed	Damage
F0	40-72 mph	light
F1	73-112 mph	moderate
F2	113-157 mph	considerable
F3	158-206 mph	severe
F4	207-260 mph	devastating
F5	261-318 mph	incredible

FunFacts!

- Only a small percentage of tornadoes that occur each year are classified as F5 on the Fujita scale, with winds ranging from 261-318 mph. No tornado is believed to have ever exceeded the F5 category.
- Tornadoes in the United States have an average path length of about 5 miles and an average width of 160-170 yards.
- Most tornadoes rotate counterclockwise. However, about 1 in 100 will rotate clockwise.
- Tornadoes have been known to occur on every continent except Antarctica.
- Most tornadoes strike between 5 pm and 6 pm.
- Less than one percent of all thunderstorms will produce a tornado.

Activities and Games

Tornado Alley

Tornado Alley is the nickname given to the area of the United States that experiences more tornadoes—especially strong tornadoes (F2-F5)— than anywhere on earth.

The map below shows the average number of strong tornadoes (F2-F5) reported each year for each state in the U.S. from 1950-1995. Using the numbers on the map, color-in the states based on the following criteria:

- Color states that have an average number of strong tornadoes between 0 and 5 **green**.
- Color states that have an average number of strong tornadoes between 6 and 10 **yellow**.
- Color states that have an average number of strong tornadoes greater than 10 **red**.

Now take a look at the map you just colored in. Do you see a pattern of where strong tornadoes are most likely to occur? Use a pencil or marker and draw an outline of where *you think* Tornado Alley should be.

Annual Average Number of Strong (F2-F5) Tornadoes, 1950-1995

Quick Quiz

1. What are some of the main ingredients necessary for a tornado to develop?

2. What is the average path length of a tornado in the United States?

3. Which states see the highest number of strong tornadoes in an average year ?

4. In what year was F-Scale first developed?

5. What is a Tornado Vortex Signature?

Learn More About It

Now that you've learned some of the basics about how and where tornadoes form, are detected, and how they're classified, you may want to learn more about these powerful and deadly storms.

Below are some web sites that offer more information about weather instruments:

The Tornado Project Online! includes information on past tornadoes, tornado myths, storm shelters, and a tornado FAQ section:

http://www.tornadoproject.com

The Storm Prediction Center has a tornado FAQ that that covers tornado basics, forecasting, damage, safety, research, and more:

http://www.spc.noaa.gov/faq/tornado/index.html

The National Climatic Data Center's tornado page has links to statistics and graphics showing long-term and average number of tornadoes by state as well as reports on historic tornado outbreaks:

http://lwf.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

Also, be sure to check out our website for more educational and climate data resources:

http://www.sercc.com

Southern AER
Southeast Regional Climate Center
SC Department of Natural Resources
2221 Devine Street, Suite 222
Columbia, South Carolina 29205